# APPENDIX A: INFLATION AND DISCOUNTING FACTORS

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# APPENDIX A: INFLATION AND DISCOUNTING FACTORS

## A.1 Introduction

This appendix provides information on the inflation of medical services and computations that can be used to calculate the present value of future costs. This information can be used to modify the values presented in the various Handbook chapters.

The chapters typically present various cost components that are expressed in the year that the data were obtained (i.e., unadjusted, or "original," dollar value). The final cost estimates are presented inflated to the dollar value in the year the chapter was completed (i.e., adjusted, or "present," dollar value). For example, in the tables leading up to the final cost calculations, data from a 1995 study are listed in the original (1995) dollars. When the various cost components are summed to calculate a total estimated medical cost, the final results are presented in present dollars for the year that the Handbook chapter was prepared, usually 1996 through 1999. The inflation factors data provided in this appendix, which are based on the Consumer Price Index Medical Care Services, can be used to obtain:

1) a current valuation of an interim cost component to a year other than the year of the Handbook presented in one of the early tables in a chapter, or

2) an inflated valuation of the final cost estimate (e.g., prior to 1999).

Methods to do this are described below. Inflation factors for future years will be added to this appendix as they become available.

Each chapter presents the final estimated costs with both zero discounting and with various discount rates, usually, one, three, five, and seven percent. The cost components leading up to the final cost estimate, however, are presented without discounting. Discounting of individual cost components is not usually required, and is therefore not included in the chapter. If those data are required, then the discounting factors and methods described below can be used to carry out discounting of any value presented in the Handbook, projected into the future for up to 20 years. It is assumed that if an analyst wishes to discount further into the future, then he or she can use the formula provided below to perform those calculations.

## A.2 Inflation

Medical costs, along with most other costs, increase over time. These increases have been borne out especially in recent decades. The Consumer Price Index (CPI), which is determined by the U.S. Department of Commerce's Bureau of Labor Statistics, provides a U.S. Medical Care Services inflation value for each year, based on a review of the costs of medical services. A variety of services are reviewed by the Department of Commerce to calculate this value. Detailed information on their methods of calculation and sources of information can be obtained at their website URL (click below to link):

*http://146.142.4.24/cgi-bin/surveymost?cu*

CPI Medical Care Services inflation are provided in Table A.1 below for the years 1980 through 1999. The factor listed for each year can be used to inflate the cost provided in the previous years dollars (see text). Because the inflation rate is based on data from the entire year, the value to be used for the year 2000 will not be available until 2001. The for future years can be obtained directly from the above-listed URL when they become available.

**Table A.1 Inflation Factors from the CPI**

| Year | Annual Factor | Factor to Convert to 1999$ |
|---|---|---|
| 1980 | 74.80 | 3.41 |
| 1981 | 82.80 | 3.08 |
| 1982 | 92.60 | 2.75 |
| 1983 | 100.70 | 2.53 |
| 1984 | 106.70 | 2.39 |
| 1985 | 113.20 | 2.25 |
| 1986 | 121.90 | 2.09 |
| 1987 | 130.00 | 1.96 |
| 1988 | 138.30 | 1.84 |
| 1989 | 148.90 | 1.71 |
| 1990 | 162.70 | 1.57 |
| 1991 | 177.10 | 1.44 |
| 1992 | 190.50 | 1.34 |
| 1993 | 202.90 | 1.26 |
| 1994 | 213.40 | 1.20 |
| 1995 | 224.20 | 1.14 |

| Table A.1 Inflation Factors from the CPI | | |
|---|---|---|
| **Year** | **Annual Factor** | **Factor to Convert to 1999$** |
| 1996 | 232.40 | 1.10 |
| 1997 | 239.10 | 1.07 |
| 1998 | 246.80 | 1.03 |
| 1999 | 255.10 | 1.00 |

Adapted from the U.S. Department of Commerce Bureau of Labor Statistics, 2000. URL: http://146.142.4.24/cgi-bin/surveymost?cu

The information in Table A.1 can be used with a cost provided in dollars for any year from 1980 through 1998 (1999 does not need adjustment during the year 2000). The table is set up so that data from any of these years can easily be carried forward to 1999 dollars. For example, if a medical cost of $200.00 was incurred in 1983, then the multiplier of 2.53 would be applied to yield the following:

$$\$200.00 \times 2.53 = \$506 \text{ in 1999 dollars.}$$

Although costs can be calculated for years prior to the current year (i.e., 1999), this requires an additional calculation. It was assumed that such a calculation would rarely be used, since interim year costs are not generally of use. For example, if a 1987 cost of $200.00 was desired in 1991 dollars, then a new conversion factor would need to be calculated. The conversion factor is determined by dividing the CPI value of the year to which the analyst wishes to inflate (in this case 1991) by the CPI value of the year from which the data are taken. In this example, the CPI value is 177.10 for 1991, and 130.00 for 1987. The new conversion factor is the quotient of these two numbers:

$$\text{CPI value 1991/CPI value 1987} = 177.10/130.00 = 1.36$$

This new conversion factor is multiplied by the 1987 cost of $200.00 to obtain the 1991 cost:

$$1.36 \times \$200.00 = \$272.00 \text{ in \$1991.}$$

There are uncertainties associated with use of these factors. The CPI are based on average increases in costs. Some medical services increase more than others during a given year. Given the uncertainty inherent in the estimated medical costs provided in this Handbook, such uncertainties are not likely to have a substantial impact. Most medical costs of diseases that are presented in the Handbook represent an aggregate of costs arising from

many types of services and materials, and can be inflated with the CPI-generated inflation factors, which also are derived from a spectrum of services and materials.

## A.3 Discounting

Discounting is used by economists when costs are to be incurred in the future. It is applied to make future costs comparable to current costs because consumers have a preference for current consumption compared to future consumption. Because health-related costs limit the funds available for consumption, a consumer would prefer to postpone payment of a given cost and the resulting reduction in consumption into the future. The current value of a given dollar amount to a consumer is therefore less if it has to be paid in the future than if it is incurred today.

The present value of costs are calculated by taking into account the amount of time between the present and the point when the costs are incurred, and by making some assumption regarding the degree to which current consumption is more highly valued. This amount is usually expressed as a present value discount rate ranging from one to ten percent, although it is possible to use no (0) discounting or to apply a higher rate. This chapter uses the discount rates most commonly used by EPA of one, three, five, and seven percent. Costs are also presented in undiscounted form.

The basic equation used to carry out discounting is:

$$PV = C\ (1+r)^{-t}$$

where: PV = present discounted value
C = future cost to be incurred
r = discount rate
t = number of years to be discounted

Table A.2 shows the factors that can be used to apply this equation to a specific cost (C), when one uses these discount rates over specific periods of time. The number of years is calculated by subtracting the present year from the future year. For example, to discount a cost to be incurred in 2010 to the year 2000, a discounting factor for year 10 in the table would be used (2010-2000 = 10). These factors were calculated using the portion of the above equation: $(1+r)^{-t}$, to obtain a simple multiplier corresponding to each discount rate and the first 20 years into the future. For example, a cost of $300 discounted for 10 years at five percent would result in the following calculating using the equation above without discounting factors:

$$PV = \$300 \times (1 + 0.05)^{-10} \quad = \$183$$

Using the factors in Table A.2, a simpler equation can be used with the factor of 0.61 for five percent at 10 years:

$$PV = \$300 \times .61 = \$183.$$

It is important to note that the years listed in the table represent the number of years in the future one wishes to discount to (i.e. Year 1 represents one year in the future). The number of years is calculated by subtracting the present year from the future year of interest. For example, to discount a cost to be incurred in 2010 to the year 2000, a discounting factor for year 10 from Table A.2 would be used (2010 – 2000 = 10). The discounting factors can be applied to costs presented in the Handbook to obtain the present discounted value of an individual cost or a stream of costs, as discussed below.

**Table A.2 Discounting Factors for 20 Years into the Future**
**Factors are the multipliers applied to the original cost to obtain a discounted cost (see text).**

| Year | 1% | 3% | 5% | 7% |
|---|---|---|---|---|
| 1 | 0.99 | 0.97 | 0.95 | 0.93 |
| 2 | 0.98 | 0.94 | 0.91 | 0.87 |
| 3 | 0.97 | 0.92 | 0.86 | 0.82 |
| 4 | 0.96 | 0.89 | 0.82 | 0.76 |
| 5 | 0.95 | 0.86 | 0.78 | 0.71 |
| 6 | 0.94 | 0.84 | 0.75 | 0.67 |
| 7 | 0.93 | 0.81 | 0.71 | 0.62 |
| 8 | 0.92 | 0.79 | 0.68 | 0.58 |
| 9 | 0.91 | 0.77 | 0.64 | 0.54 |
| 10 | 0.91 | 0.74 | 0.61 | 0.51 |
| 11 | 0.90 | 0.72 | 0.58 | 0.48 |
| 12 | 0.89 | 0.70 | 0.56 | 0.44 |
| 13 | 0.88 | 0.68 | 0.53 | 0.41 |
| 14 | 0.87 | 0.66 | 0.51 | 0.39 |
| 15 | 0.86 | 0.64 | 0.48 | 0.36 |
| 16 | 0.85 | 0.62 | 0.46 | 0.34 |
| 17 | 0.84 | 0.61 | 0.44 | 0.32 |
| 18 | 0.84 | 0.59 | 0.42 | 0.30 |
| 19 | 0.83 | 0.57 | 0.40 | 0.28 |
| 20 | 0.82 | 0.55 | 0.38 | 0.26 |

Often, analysts evaluate a stream of costs incurred on a regular basis over many years. This method requires a more complex calculation. The present discounted value must be calculated independently for each year that new costs are introduced. When medical costs are likely to occur sequentially over time, such as long term care or monitoring for chronic diseases, the present discounted value is calculated for those costs incurred in each year in the future. That is, the appropriate factor is multiplied by the cost for each individual year of service. These costs are then summed to obtain the total present discounted value of the long-term treatment.

For example, a common occurrence is that follow up medical monitoring is required after an initial high cost treatment year. If the follow up costs $500.00 per year for five years into the future, then the total present value of the follow-up care can be calculated by summing the present for each of those five years. Assume that the monitoring costs are discounted at three percent. The factors taken from Table A.2 for a three percent discount rate are multiplied by $500 as follows:

$$0.97 \times \$500 + 0.94 \times \$500 + 0.92 \times \$500 + 0.89 \times \$500 + 0.86 \times \$500 = \$2{,}289.85.$$
(Year 1) (Year 2) (Year 3) (Year 4) (Year 5)

It is usually advisable to set up the factors in a spreadsheet to carry out this type of calculation if costs extend long into the future, or if there are numerous discount rates or cost elements being considered.

When calculating the present value of medical services, it is essential to determine the timing of those services. In many cases, there are various levels of care that gradually decline over time, but in some cases these may increase (e.g., when it is estimated for non-surviving patients that terminal care will be provided at some point in the future). Consequently, there may be different costs incurred at different points in the future, and these must each be discounted appropriately. As noted above, *each chapter presents the final medical cost estimates both of undiscounted and present discounted , that take the specific staging and timing of services into account.* It is therefore not necessary to perform discounting calculations unless interim or partial cost calculations are required, as in the case, for example, of the need for only hospitalization or pharmaceutical costs for asthmatics, but not the full spectrum of costs for all medical services. Due to the relatively unlikely need for such data, the discounted of components of total costs were not provided in the chapters.

Additional data or guidance needed on the genesis and application of inflation or discounting factors can be found in most basic economic text books.